



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

February 22, 2004

Volunteer Fire Fighter Suffers Sudden Cardiac Death After Completing Emergency Medical Technician (EMT) Written Examination –Texas

SUMMARY

On December 13, 2002, a 29-year-old male volunteer Fire Fighter completed the written examination portion of his Emergency Medical Technician (EMT) certification. After turning in the examination he excused himself to the restroom. After approximately 10-15 minutes, he was found lying on the restroom floor unresponsive with no pulse and no respirations. Cardiopulmonary resuscitation (CPR) was begun immediately and an ambulance was requested. Approximately 56 minutes later, despite CPR and advanced life support (ALS) administered on the scene and at the hospital, the victim died. The death certificate, completed by the Justice of the Peace listed “acute myocardial infarction” as the immediate cause of death.

The following recommendations address some general health and safety issues. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These selected recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups. While these recommendations could be used at this Fire Department, it is unlikely any of these measures could have prevented this victim’s untimely death.

- **Conduct pre-placement and periodic medical evaluations to determine the fire fighter’s medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.**

- **Fire fighters with two or more risk factors should have an Exercise Stress Test (EST).**
- **Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582 and the results of the exam are discussed with the fire fighter.**
- **Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.**
- **Designate a City employee to administer the pre-placement and annual medical evaluations and their outcomes.**
- **Perform an autopsy on all on-duty fire fighter fatalities.**

Although unrelated to this fatality, the Fire Department should consider these additional recommendations:

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at www.cdc.gov/niosh/firehome.html or call toll free 1-800-35-NIOSH

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- ***Provide fire fighters with medical evaluations and clearance to wear SCBA.***

INTRODUCTION & METHODS

On December 13, 2002, a 29-year-old male volunteer Fire Fighter lost consciousness after completing a written examination for an EMT class. Despite CPR and ALS administered by fellow students, the EMT course instructor, the ambulance crew, and in the emergency department, the victim died. On January 7, 2003, NIOSH contacted the affected Fire Department to initiate the investigation. On August 25, 2003, an Occupational Nurse Practitioner and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Texas to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel spoke with the following:

- Fire Chief
- Crew members
- Ambulance paramedics
- Victim's wife
- State Fire Marshal's Chief Investigator
- EMT program chair
- City Secretary
- Victim's parents

During the site visit NIOSH personnel reviewed:

- Fire Department incident report
- Emergency medical service (ambulance) incident report
- Hospital emergency department report
- Death certificate
- Past medical records of the deceased
- State Fire Marshal's Line of Duty Death Investigation
- Fire Department policies and operating guidelines
- Fire Department training records
- Fire Department annual report for 2002

INVESTIGATIVE RESULTS

Incident. On December 13, 2002, at approximately 2000 hours, the Fire Fighter completed his final written EMT examination and excused himself to the bathroom. After a ten to fifteen minute absence his wife, who was waiting for the deceased, asked a fellow student to check on him. He was found unresponsive with no pulse or respirations; his eyes were fixed and dilated. Students and the instructor immediately called 911 and began cardiopulmonary resuscitation (chest compressions and assisted ventilations via mouth-to-mouth). The Emergency Medical Services (EMS) ambulance arrived at 2019 hours. A defibrillator was placed on the victim revealing asystole, a non-perfusing cardiac rhythm incompatible with life. Two stacked increasing defibrillations were administered without change in the Fire Fighter's heart rhythm. The victim was then successfully intubated. Placement was verified visually and with bilateral breath sounds by the ambulance EMT and the EMT course instructor, however no secondary placement methods (bulb or end tidal CO₂) were used. Intravenous access was unsuccessful and, according to ALS protocol, one milligram (mg) of Epinephrine was administered via the endotracheal tube (ETT). A third shock was administered with no change in the Fire Fighter's heart rhythm. The Fire Fighter was loaded into the ambulance and departed the scene at 2035 hours.

Enroute, ALS protocol medications were administered via ETT and he was shocked two more times. The ambulance arrived at the local hospital's Emergency Department (ED) at 2040 hours (hospital records state the ambulance arrived at 2030 hours). During movement from the ambulance to the hospital's ER, the ETT became dislodged. The physician in the ED reintubated the Fire Fighter with placement verified by bilateral breath sounds only. Inside the ED, the Fire Fighter's heart rhythm remained in asystole. CPR and ALS measures continued until 2056 hours when the Fire Fighter was pronounced dead by the attending physician.



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Medical Findings.

The death certificate was completed by the Justice of the Peace, who listed “Acute Myocardial Infarction” as the immediate cause of death. No autopsy was performed. The Fire Fighter had the following risk factors for coronary artery disease (CAD): family history, male gender, smoking, hypertension, hypertriglyceridemia, hypercholesterolemia, physical inactivity and obesity [Body Mass Index (BMI) of 36.1 kg/m² (A BMI above 30 kg/m² indicates obesity)]¹. The victim was currently prescribed a cholesterol-lowering medication but not was taking it. The Fire Fighter’s last medical evaluation was in February 2002, where no mention was made of clearance for fire fighting duties.

According to his wife and classmates, the Fire Fighter did express chest tightness the day of this incident but, he attributed it to a muscle injury from playing football that afternoon. Because of the chest tightness he requested a classmate run a rhythm strip from a cardiac monitor but the monitor was unavailable. He stated he would go to his fire station and have a strip run by his crew members (EMT-Paramedics) after class.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the combination Fire Department consisted of two full-time fire fighters, three EMS personnel, and 20 volunteer fire fighters and served a population of 2,596 in a geographic area of 250 square miles. There is one fire station.

Training. New career fire fighter applicants must possess a State Class B driver’s license and pass a background check and an oral interview. Once hired, fire fighters must become State-certified fire fighters and EMT-Basic within one year.

New volunteer fire fighter applicants must be over age 18, possess a State Class B driver’s license, pass an oral interview, and confirm if they have a police record. Once selected, the fire fighter must attend training and emergency responses. The volunteer fire fighter receives training on the essentials of fire fighting in-house or attends the State Fire Academy. State certification is voluntary; however, the fire fighter must be trained to the Fire Fighter 1 level before fighting structure fires. Fire fighters receive recurrent training in their station at weekly drills. The State requirement for minimum volunteer fire fighter certification is 167 hours for Basic Fire Fighter, an additional 193 hours for Intermediate Fire Fighter, and an additional 187 hours for Advanced Fire Fighter. State Fire Academy consists of 580 hours and trains fire fighters to the Fire Fighter-Basic/EMT-Basic level.

All fire fighter applicants who wish to be State-certified must pass a written State test.

The State requirement for annual State-certified fire fighter recertification is 20 hours. Annual recertification is also required for hazardous materials certification. First Responders, EMTs and Paramedics recertify every two years. The victim was not certified as a Fire Fighter, and he had seven months of fire-fighting experience.

Pre-placement Evaluations. The Fire Department does not require a pre-placement medical evaluation for new members. A performance evaluation of flexibility and endurance (shooting basketball in full turnout gear and SCBA) is required for new members.

Periodic Evaluations. No annual medical evaluations or physical ability tests are required by the Department. Fire fighters are encouraged to receive a complete physical examination through their

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employer or at their own expense. Medical clearance for SCBA use is not required. If a fire fighter is injured on duty or is ill and misses work, he/she must be cleared for return to work by his/her personal physician. Strength equipment is available at the fire station but not aerobic equipment. No wellness program is available.

DISCUSSION

Because no autopsy was performed, a definitive “cause of death” cannot be determined. Possible causes include a congenital heart abnormality, heart attack (myocardial infarction), heart arrhythmia, or pulmonary embolus. His clinical scenario is most consistent with a heart arrhythmia leading to sudden cardiac death. Due to the nature of the chest pain complaints, it is also possible the victim had a heart attack. The term “possible” is used because autopsy findings (thrombus formation), ECG findings, or blood tests (cardiac isoenzymes) are required to “confirm” a heart attack (myocardial infarction). No autopsy was performed and the victim had no heart beat to show the characteristic findings of a heart attack on his ECG. Cardiac enzymes were Myoglobin 140 nanograms per milliliter (ng/mL) (normal 23-72 ng/mL), CK 139 units per liter (U/L) (normal 5-137 U/L), Troponin T 0.076 ng/mL (normal 0.000-0.099 ng/mL), and CK-MB 4.1 ng/mL (normal 0.1-5.0 ng/mL). Although some enzymes are elevated, the key cardiac enzymes, CK-MB or Troponin, are within normal limits. The elevated enzymes listed above were probably the result of two conditions: playing football (trauma to the chest), and/or the multiple shocks delivered by the resuscitation attempts.

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.² Risk factors for its development include age over 45, male gender, family history of coronary artery disease,

smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.^{3,4} The victim had seven of these risk factors (male gender, family history, smoking, high blood pressure, high blood cholesterol, physical inactivity and obesity). He never complained of symptoms suggestive of congestive heart failure (shortness of breath, dyspnea on exertion, swollen ankles, etc.) but did complain of chest pain the night of his death. Unfortunately, sudden cardiac death is the presenting condition in up to 20% of cases of coronary artery disease (CAD).

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.⁵ However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.⁶ Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.⁷ This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. Blood clots, or thrombus formation, in coronary arteries are initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.⁷ Disruption then occurs from biomechanical and hemodynamic forces, such as increased blood pressure, increased heart rate, increased catecholamines, and shear forces, which occur during heavy exercise.^{8,9}

To reduce the risk of heart attacks and sudden cardiac arrest among fire fighters, the NFPA has developed the NFPA 1582 guideline entitled *Comprehensive Occupational Medicine Program for Fire Departments*.¹⁰ NFPA 1582 recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual acuity test.¹⁰ NFPA 1582 recommends a thorough



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examination to include vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery be conducted on a periodic basis according to the age of the fire fighter (less than 30: every 3 years; 30-39: every 2 years; over 40 years: every year). This Fire Department does not currently offer pre-placement or periodic physical evaluations to fire fighters.

NFPA 1582 also recommends fire fighters with two or more risk factors for CAD (family history of premature [less than age 60] cardiac event, hypertension, diabetes mellitus, hypercholesterolemia [total cholesterol greater than 240 mg/dL or HDL cholesterol less than 35 mg/dL], and cigarette smoking) be screened for obstructive CAD by an EST.¹⁰ These recommendations are similar to those of the American College of Cardiology/American Heart Association (ACC/AHA). The ACC/AHA recommends EST for (1) asymptomatic men over the age of 40 with a history of cardiac disease (as a screening test before beginning a strenuous exercise program), and (2) men over age 40 with one or more risk factors.¹¹ They define five risk factors for CAD: hypercholesterolemia (total cholesterol greater than 240 mg/dL), hypertension (systolic greater than 140 mm Hg or diastolic greater than 90 mm Hg), smoking, diabetes, and family history of premature CAD (cardiac event in first-degree relative less than 60 years old).¹² The U.S. Preventive Services Task Force (USPSTF) does not recommend EST for asymptomatic individuals, even those with risk factors for CAD; rather, they recommend the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes).¹³ On the other hand, the USPSTF states, “screening individuals in certain occupations (pilots, truck drivers, etc.) can be recommended on other grounds, including the possible benefits to public safety.”¹³

Since the victim had four risk factors for CAD (family history, hypertension, cigarette smoking, and

hypercholesterolemia) an EST would have been recommended by NFPA 1582. However, the AHA and the USPSTF are less clear about whether an EST should have been performed in this individual. It is possible an EST may have identified whether the victim had CAD or a dysrhythmia and possibly led to medical treatment that would have prevented his sudden cardiac death.

RECOMMENDATIONS

The following recommendations address health and safety generally. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of technical committees of the NFPA or fire service labor/management groups.

Recommendation #1: Conduct pre-placement and periodic medical evaluations to determine the fire fighter’s medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

The purpose of periodic medical evaluations is to ensure that fire fighters have the ability to perform duties without presenting a significant risk to the safety and health of themselves or others. Guidance regarding the content and scheduling of periodic medical examinations for fire fighters can be found in NFPA 1582.¹⁰ In addition to providing guidance on the frequency and content of the medical evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire fighting tasks. NFPA 1582 recommends a limited annual evaluation, including a medical and occupational history, and a limited physical examination (height, weight, blood pressure, heart rate and rhythm). In addition, NFPA 1582 recommends a more extensive

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medical evaluation at an interval of 1 to 3 years, depending on the fire fighter's age. NFPA 1582 recommends exercise stress tests for those fire fighters with two or more CAD risk factors.

Applying NFPA 1582 involves legal and economic issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department administrators regarding legal considerations in applying the standard. The economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, addresses these issues in Chapter 8-7.1 and 8-7.2.¹⁴ The success of medical programs hinges on protecting the affected fire fighter. The department must (1) keep the medical records confidential, (2) provide alternate duty positions for fire fighters in rehabilitation programs, and (3) if the fire fighter is not medically qualified to return to active fire-fighting duties, provide permanent alternate duty positions or other supportive and/or compensated alternatives. Unfortunately, the second and third requirements may not be workable in a volunteer department and could thus impair both acceptance by fire fighters and the fire department's ability to recruit and retain fire fighters.

Applying this recommendation involves economic repercussions and may be particularly difficult for small, rural, volunteer fire departments to implement. To overcome the financial obstacle, the Fire Department could urge current members to get annual medical clearances from their private physicians (also see Recommendation #3). Another option is having the brief annual medical evaluations recommended by NFPA 1582 completed by the volunteer fire fighters themselves (medical and occupational history) and by EMTs from the county's

emergency medical service (vital signs, height, weight, and visual acuity). This information could then be provided to a community physician, perhaps volunteering his or her time, to review the data and provide medical clearance (or further evaluation, if needed). The more extensive periodic medical examinations could be performed by a private physician at the fire fighter's expense, provided by a physician volunteer, or paid for by the Fire Department. Sharing the financial responsibility for these evaluations between volunteers, the Fire Department, and willing physician volunteers should reduce the negative financial impact on recruiting and retaining needed volunteers.

Recommendation #2: Fire fighters with two or more risk factors should have an Exercise Stress Test (EST).

Recommendation #3: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582 and the results of the examination are discussed with the fire fighter..

Physicians providing input regarding medical clearance for fire-fighting duties should be knowledgeable about the physical demands of fire fighting and familiar with the consensus guidelines published by NFPA 1582. To ensure physicians are aware of these guidelines, we recommend that the Fire Department provide the contract and private physicians with a copy of NFPA 1582. In addition, we recommend the Fire Department not automatically accept the opinion of the employee's private physician regarding return to work. This decision requires knowledge not only of the employee's medical condition but also of the employee's job duties. Frequently, private physicians are not familiar with an employee's job duties or with guidance documents such as NFPA



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1582. Lastly, we recommend that all return-to-work clearances be reviewed by a County/Fire Department contracted physician. Thus, the final decision regarding medical clearance for return to work lies with the County/Fire Department with input from many sources including the employee's private physician.

Recommendation #4: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors, namely obesity and diabetes.¹⁵ NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, require a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.^{14,16} In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) published a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual and a video detailing elements of such a program.¹⁷ The Fire Department should review these materials to identify applicable elements. Other large-city negotiated programs can also be reviewed as potential models. Small volunteer fire departments should review the programs mentioned above and determine which components are practical for them.

Recommendation #5: Designate a City employee to administer the pre-placement and annual medical evaluations and their outcomes.

This employee should maintain the confidentiality of the medical records. If this employee is a member of the FD and participating in the City's annual medical evaluation, a policy should prevent them from administering the program to themselves.

Recommendation #6: Perform an autopsy on all on-duty fire fighter fatalities.

In 1995, the United States Fire Administration (USFA) published the Firefighter Autopsy Protocol.¹⁸ This publication hopes to provide "a more thorough documentation of the causes of firefighter deaths for three purposes:

- (1) to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
- (2) to help determine eligibility for death benefits under the Federal government's Public Safety Officer Benefits Program, as well as state and local programs; and
- (3) to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired."

This finding did not contribute to this fire fighter's death, but was identified during the NIOSH investigation.

Recommendation #7: Provide fire fighters with medical evaluations and clearance to wear SCBA.

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations

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and clearance for employees using respiratory protection.¹⁹ These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. Texas is not a State-plan State; therefore, public sector employers are not required to comply with OSHA standards. Nonetheless, we recommend voluntary compliance with the Respiratory Protection Standard. A copy of the OSHA medical checklist has been provided to the Fire Department.

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